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ABSTRACT

This report describes the current version of the Why System, a script-based Socratic tutor which uses tutoring strategies formulated as production rules. The current system is capable of carrying on a dialogue about the factors influencing rainfall by presenting different cases to the student, asking for predictions, probing for relevant factors, entrapping the student when he has not identified all necessary factors, and presenting counterexamples. This system is incomplete because it lacks a goal structure to guide the tutorial sessions. The report outlines a more complete theory of the goal structure of Socratic tutors based on analysis of human tutorial dialogues. The main goals are to refine the student's causal model and predictive abilities. Sub-goals include the diagnosis of deficiencies in the student's knowledge and the correction of these deficiencies. (Author)

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The Goal Structure of a Socratic Tutor

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presenting counterexamples. The current system is incomplete because it lacks a goal structure to guide the tutorial sessions. We outline a more complete theory of the goal structure of Socratic tutors based on analysis of human tutorial dialogues. There are two top level goals: (1) refinement of the student's causal model and (2) refinement of the student's predictive abilities. The subgoals are diagnosis of bugs in the student's knowledge and correction of the bugs. This goal-driven control mechanism governs the selection of examples and teaching strategies used by the tutor.

The Goal Structure of a Socratic Tutor

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Abstract

We describe the current version of the Why System, a script-based Socratic tutor which uses tutoring strategies formulated as production rules. The current system is capable of carrying on a dialogue about the factors influencing rainfall by presenting different cases to the student, asking for predictions, probing for relevent factors, entrapping the student when he has not identified all necessary factors, and presenting counterexamples. The current system is incomplete because it lacks a goal structure to guide the tutorial sessions. We outline a more complete theory of the goal structure of Socratic tutors based on analysis of human tutorial dialogues. There are two top level goals: (1) refinement of the student's causal model and (2) refinement of the student's predictive abilities. The subgoals are diagnosis of bugs in the student's knowledge and correction of the bugs. This goal-driven control mechanism governs the selection of examples and teaching strategies used by the tutor.

The Goal Structure of a Socratic Tutor

Albert L. Stevens and Allan Collins

INTRODUCTION

The technology for building intelligent CAI systems that can tutor students individually is advancing rapidly because of an accumulation of tools and techniques for representing knowledge and understanding language (Brown & Burton, 1975; Burton, 1976; Norman & Rumelhart, 1975; Schank & Abelson, in press). We are using these tools to build the Why System, a Socratic tutor which teaches causal knowledge and reasoning about the factors influencing rainfall in different regions.

The Socratic or case method (Collins, 1977; Plato, 1924; Swets & Feurzeig, 1965) is one of the most effective methods of teaching. By posing problems for the student to solve, the student learns the way different facts are causally interrelated as well as strategies for using this knowledge to reason in a generative way (Collins, Warnock, Aiello & Miller, 1975). This is the kind of knowledge and skill that a person cannot learn passively by reading a book or by having the causal interdependencies explained. He must actively try to deal with problems and cases, and make mistakes that reveal his misunderstandings.

In order to develop the Why System, we examined a variety of dialogues involving the Socratic method and tried to formalize the tutoring strategy used in these dialogues as production rules (Newell & Simon, 1972). Production rules take the form "If in situation X,

do Y". The purpose of writing the rules as productions was to express the theory in a procedural formalism, independent of the particular content.

Based on our analysis, we developed a theory of Socratic tutoring (Collins, 1977) in the form of twenty-four production rules which account for the specific strategies used in the dialogues analyzed. Examples of these rules are shown in the dialogue in Table 1. The strategies themselves teach students: (1) information about different cases, (2) the causal dependencies that underlie these cases, and (3) a variety of reasoning skills. These latter include such abilities as forming hypotheses, testing hypotheses, distinguishing between necessary and sufficient conditions, making uncertain predictions, determining the reliability or limitation of these predictions, and asking the right questions when there is not enough information to make a prediction.

Table 1 shows segments of an actual dialogue with the Why System which illustrate some of its capabilities. The student's responses are typed between asterisks. The Socratic rules that generated the system's questions are shown in parentheses, but these are not seen by the student.

The system's knowledge about rainfall is stored in scripts and subscripts (Schank and Abelson, in press). The scripts represent the different temporal steps and causal factors in structures that affect rainfall. The language comprehension module is implemented as a semantic grammar (Burton, 1976) and matching procedure which attempts to identify which of the steps and factors the student refers to in

Table 1

Dialogue with why System

DO YOU THINK THE AMAZON JUNGLE HAS HEAVY RAINFALL OR LITTLE RAINFALL? (Rule 1: Ask for a prediction about a particular case)

HEAVY RAINFALL

WHY DOES THE AMAZON JUNGLE HAVE HEAVY RAINFALL? (Rule 2: Ask for prior causes)

BECAUSE IT'S NEAR THE ATLANTIC

YES, THE AMAZON JUNGLE IS NEAR THE EQUATORIAL ATLANTIC. HOW DOES THAT AFFECT THE RAINFALL IN THE AMAZON JUNGLE? (Rule 3: Ask for intermediate causes)

THE WATER IN CURRENT IS WARM

(section omitted)

WHAT HAPPENS AFTER THE MOISTURE FILLED AIR REACHES THE LAND? (Rule 4: Ask for subsequent causes)

I DON'T KNOW

DO YOU THINK THE ANDES MOUNTAIN RANGE HAS ANY EFFECT ON THE RAINFALL IN THE AMAZON JUNGLE? (Rule 5: Suggest a factor and ask if it is a cause)

YES

HOW? (Rule 3: Ask for intermediate causes)

THE PREVAILING WIND HITS THE ANDES AND THE AIR COOLS

HOW DOES THE FACT THAT PREVAILING WIND HITS THE ANDES, LEAD TO AIR COOLING? (Rule 3 again)

(section omitted)

DO YOU THINK THAT ANY PLACE WITH MOUNTAINS HAS HEAVY RAINFALL? (Rule 6: Form a general rule for an insufficient cause)

YES

SOUTHERN CALIFORNIA HAS MOUNTAINS. WHY DOESN'T SOUTHERN CALIFORNIA HAVE HEAVY RAINFALL? (Rule 7: Pick a counter-example for an insufficient cause, and Rule 2: Ask for prior causes)

his responses. The language comprehension module uses very general techniques for parsing and representing English, but in its current form it deals with only a limited set of natural inputs. It does not deal well with anaphora or conjunction and fails to understand many sentences typed by the students.

The first segment of Table 1 shows the start of a dialogue about rainfall in the Amazon, a case which students typically have some information about. The first strategy in taking up a new case is to ask for a prediction. When the correct answer is given, the system asks for any of the prior causes that lead to rainfall in the Amazon. Because the student mentions the Atlantic, the system follows up on this to see if the student knows how the Atlantic is involved in the process leading to rainfall. To do this, it asks for any intermediate steps in the causal structure between the Atlantic and the rainfall in the Amazon.

The next segment follows an omitted discussion with the student about how water evaporates from the Atlantic and is carried by the prevailing winds over the Amazon. Having discussed these two basic steps in the process, the system asks what happens next. When the student doesn't know the answer, one of the strategies the system uses is to suggest a factor, such as the Andes, which is involved in the process, and ask if that is a cause of rainfall. When the student agrees that it is, the system probes for intermediate steps in the process by asking "How?" The student's answer "The prevailing winds hit the Andes and the air cools," refers to two separate steps in the process. Because there is an intervening step between these

two steps, the system probes the student for that intervening step.

In the last segment, the first question involves one kind of entrapment Socratic tutors use. The strategy is to pick a factor, such as mountains, that is involved in the process of rainfall, but is not sufficient in and of itself. Then a question is posed as to whether the factor is sufficient to cause heavy rainfall. In this case, when the student is trapped into saying yes, the system asks about a counterexample, Southern California, which has mountains but not heavy rainfall. The dialogue would continue from this point, on the topic of why Southern California has little rainfall. This kind of use of entrapment and counterexample are characteristic of the Socratic method.

As has been pointed out (Collins, 1977; Resnick, 1977) the Socratic theory on which the current system is based does not characterize the goals of Socratic tutors. The different rules are triggered by specific situations, but there is no explicit control structure that specifies when tutors use particular strategies, select particular cases, or discuss particular parts of the causal structure. It is clear that tutors are in fact driven by some higher-order goals and a complete tutorial system must be goal directed. The remainder of this paper specifies a theory of that higher-level goal structure which we intend to implement as part of the why System.

Our earlier analysis of dialogues was based solely on the transcripts of Socratic dialogues. In order to investigate the goals of the tutors, we conducted new dialogues, where the questions and

responses were typed, and where the tutors commented on two aspects of the dialogue as they proceeded. The two aspects were: (1) what they thought the student knew or didn't know, based on the student's response, and (2) why they responded to the student in the way they did. Our theory of the Socratic tutor's goal structure is based on these comments.

OUTLINE OF THE THEORY

The theory we have derived is summarized in Table 2. The specific rules are shown in Table 3. Note that a specific rule often serves several purposes. A tutor's top level goals are (1) refine the student's causal model and (2) refine the student's procedures for applying the model. These directly govern the selection of cases. As the student's knowledge becomes more refined, moving from an understanding of first-order factors to higher-order factors, cases are selected which are exemplary of the factors the tutor is trying to teach. As the student's predictive ability becomes refined, cases are selected which are progressively more novel and complex, thus taxing predictive ability more and more.

This implies that goal specifications depend on the structure of the knowledge being taught. Although the theory is relatively independent of the exact form in which information is represented, we will assume that knowledge is organized in terms of embedded scripts or schemata which can be decomposed into progressively more detailed subscripts (Schank & Abelson, in press; Rumelhart and Ortony, 1977). The why System uses a script-subscript structure. It is this

Table 2

Outline of a Socratic Tutor's Goal Structure

Goals	Manifestation
Refine the student's causal model moving from 1st to nth order factors.	Case selection rules: Select cases that are exemplary of the relevent factor.
Refine the student's procedures for applying the causal model to novel cases.	Case selection rules: Select less familiar cases, exemplary of new factors.
Subgoals	
Diagnose the student's "bugs", (i.e. the difference between the student's knowledge and the tutor's knowledge.)	Ask-for-factor rules. Prediction rules. Entrapment rules. Probe-reasoning-strategy rules.
Correct the diagnosed bugs:	
a) facts	Inform-student rule
b) outside-domain models	Inform-student rule
c) over generalization	Insufficient-factor rules
d) over differentiation	Unnecessary-factor rules
e) reasoning strategy	Forming hypothesis rules Testing hypothesis rules Information-collection rules

Table 3

Basic Strategies of Socratic Tutors

(Detailed descriptions of most of these rules are in Collins 1977)

Case selection
- Ask about a particular case.
- Pick a counterexample for an insufficient factor.
- Pick a counterexample for an unnecessary factor.
- Pick an example with the same factors.

Ask for factors
- Ask for prior factors.
- Ask for intermediate factors.
- Ask for subsequent factors.
- Ask how the variable depends on a given factor.

Prediction
- Ask for a prediction about a particular case.

Entrapment
- Pose a misleading question.
- Form a general rule for an insufficient factor.
- Form a general rule for an unnecessary factor.

Probe Reasoning Strategy and Hypothesis Testing
- Request a test of a hypothesis about a factor.
- Ask what are the relevent factors to consider.
- Test for consistency with a given hypothesis.

Inform student
- Inform student of the correct fact or relationship.
- Point out a necessary factor.
- Point out a sufficient factor.

Insufficient factors
- Form a general rule for an insufficient factor.
- Pick a counterexample for an insufficient factor.
- Probe for a necessary factor.
- Point out a necessary factor.
- Probe for similarities between two cases.

Unnecessary factors
- Form a general rule for an unnecessary factor.
- Pick a counterexample for an unnecessary factor.
- Probe for a sufficient factor.
- Point out a sufficient factor.
- Probe for differences between two cases.

Information Collection

- Question prediction made without enough information.
- Point out inconsistent prediction.
- Ask for consideration of a possible value.
- Ask for consideration of relevant factors.

Forming Hypotheses

- Ask for prior factors.
- Ask for intermediate factors.
- Ask for subsequent factors.
- Form a general rule for an insufficient factor.
- Form a general rule for an unnecessary factor.
- Pick a counterexample for an insufficient factor.
- Pick a counterexample for an unnecessary factor.
- Probe for a necessary factor.
- Probe for a sufficient factor.
- Probe for similarities between two cases.
- Probe for differences between two cases.

embedded structure which represents the different levels or orders of the causal model the tutor is trying to teach. The top-level script represents prototypical cases, but more detailed subscripts are necessary to deal with higher-order factors. In our formulation of tutors' goal structures, the top-level goal of refining the student's causal model serves primarily to determine successively more detailed cutoff levels in the script structure. This is similar to the notion of web teaching (Norman, 1973), resulting in a breadth-first rather than a depth-first presentation of the information.

The process of achieving these top-level goals involves two types of subgoals: diagnosis and correction. Both of these subgoals govern the selection of basic strategies.

The purpose of diagnosis is to discover differences (either errors or omissions) between the student's knowledge and the tutor's knowledge. This generally requires that the tutor probe the student by asking for relevent factors, by requiring the student to make predictions about carefully selected cases, and by trying to entrap the student into making incorrect predictions. It is clear from our analysis of human dialogues that diagnosis cannot be characterized in terms of a simple mapping between student's errors and conceptual bugs. Rather the process involves sophisticated use of a student model and knowledge about common bugs in order to simulate the student's reasoning processes and pinpoint the underlying conceptual errors or missing information. In some cases, a single answer may reveal a whole set of bugs, while in other cases, the tutor must carefully probe the student, testing alternative hypothesized bugs to reveal the misconception.

Typically, when a conceptual bug is diagnosed, the tutor attempts to correct it. This may require a single statement for simple factual errors or an extended dialogue to correct problems in the student's causal model. We have classified the bugs into five different types, based on the strategies and priorities which are used to deal with them.

1) Factual bugs, like "it doesn't rain a lot in Oregon" are typically dealt with by simply correcting the student. This is because teaching facts is not part of the tutor's overall goal structure.
2) Outside-domain bugs are misconceptions the student has about causal structures but which the tutor has decided are outside of the domain he is currently teaching. These are also typically corrected by telling the student. For example, the relationship between the temperature of air and its moisture-holding capacity is often stated without any further explanation as to why the relationship holds.
3) Overgeneralization bugs involve the causal structures the tutor is trying to teach, and are dealt with using a richer set of basic strategies. These bugs result when a student has identified only a set of insufficient factors. The tutor attempts to force the student to see his overgeneralization by using counterexamples for the insufficient factors, probing the student for necessary factors not considered, formulating general hypotheses based on insufficient factors and pointing out necessary factors the student has not considered.

4) Overdifferentiation bugs result when a student identifies unnecessary factors. These bugs are dealt with using a rich set of strategies which parallel those used to deal with overgeneralization. The tutor uses counterexamples for the unnecessary factors, probes the student for the sufficient factors, formulates general hypotheses based on unnecessary factors and points out the unnecessary factors.

5) Reasoning strategy bugs result when a student incorrectly applies or attempts to extend his causal model. Examples of reasoning strategies we have seen tutors try to teach are: (1) forming hypotheses, (2) testing hypotheses and (3) collecting enough information before drawing a firm conclusion. For example, in teaching how to test a hypothesis a subgoal was to teach how to control relevent factors. These bugs are dealt with in a variety of ways. The tutor asks the student to consider relevent factors, possible values of the dependent variable, points out inconsistent predictions and questions predictions based on incomplete evidence. (Extensions of our current theory would probably reveal a more complete structure of these bugs and the strategies that are used to deal with them.)

Anytime several conceptual bugs have been isolated, the tutor must decide which of them to pursue. There are several heuristics that appear to determine the priorities assigned to correcting different bugs:

1. Errors before omissions.

2. Prior steps before later steps.

3. Shorter fixes before longer fixes.

4. Lower-order bugs before higher-order bugs.

Errors take priority over omissions because they have more devastating consequences. Prior steps take priority because the tutor wants to take things up in a rational order, to the degree the order is not determined by the student's responses. Shorter fixes, like telling the student the right answer, take priority because they are easier to complete. Lower-order bugs take priority because of the order implied by the overall goals. These constraints imply that the five types of bugs are given priority in the order in which they are listed above.

When more than one bug has been diagnosed, the tutor holds all but the one pursued on a goal stack, in the order of their priority. When he has fixed one bug, he pops up the next highest priority bug, and attempts to fix that. Sometimes when he is trying to fix one bug, he diagnoses another bug. If the new bug is of higher priority, he sometimes interrupts the goal he is pursuing to fix the higher priority bug. Thus in the dialogues there is a pattern of diagnosing bugs at different times and holding them until there is time to correct them.

We will illustrate the application of this theory by analyzing a particular dialogue within the framework of the theory. We used both the dialogue and the tutor's protocol to do this analysis. The dialogue is the second between this tutor and student. The first dealt with rainfall in the Amazon. The dialogue and annotations are shown in Table 4.

Table 4
Annotated Dialogue Between Human Tutor and Student

1 T: Do you think it rains much in Oregon?

(Case selection: Oregon is a paradigm case of a first order causal model of rainfall.
Diagnosis: ask for a prediction about a particular case.)

2 S: No

(S's prediction is wrong)

3 T: Why do you think it doesn't rain much in Oregon?

(Diagnosis: ask for any factors.)

4 S: I'm not exactly sure - just hypothesizing - it seems to me that the surrounding states have rather dry climate, but I really don't know anything about the geography of Oregon.

(S's error is due to a proximity inference; S has no knowledge of relevant factors)

5 T: It does in fact rain a lot in Oregon. Can you guess what causes the rain there?

(Correction: inform student.
Diagnosis: ask for prior factors.)

6 S: Well, let me see - I have a feeling that there is a mountain range nearby and the ocean i.e. Pacific, I think probably borders Oregon somewhat?

(S names 2 factors, but does not mention their relationship to rainfall.)

7 T: Yes the Pacific borders Oregon how do you think it is involved in the heavy rainfall there?

(Diagnosis: T selects prior factor; holds other factor;
Rule: ask for intermediate factors.)

8 S: I haven't really got any idea - well not quite true; I would only be guessing. Does the air (moist air) from the ocean somehow get blown over Oregon and encounter a block of some sort which causes it to rise and cool?

(S is missing three steps that are in T's model: 1. why the air is moist, 2. why it is blown over Oregon, 3. why cooling results in rain)

9 T: That's right. Why do you think the air is so moist?

(T picks first missing factor and holds others.
Diagnosis: ask for prior factors.)

10 S: I don't know

11 T: Where does the moisture in the air come from?

(Diagnosis: T believes the student does know some of the factors, so he uses the rule, asks for prior factors, to query more specifically)

12 S: Help!

(S does not know.)

13 T: The moisture evaporates from the ocean. Why do you think a lot of moisture evaporates?

(Correction: point out a necessary factor.
Diagnosis: ask for prior factors.)

14 S: Something to do with the air wind blowing which meets the air rising from the ocean and the combination of the two produce the conditions which cause the moisture to evaporate. What are those conditions?

(T concludes student has incorrect model.)

15 T: A lot of moisture evaporates because the water is relatively warm as is the air above it. Why do you think that is so?

(Correction: point out two necessary factors.
Diagnosis: ask for prior factors, T holds on stack how warmth of air and water affect evaporation).

16 S: Because of its location?

(Student names one factor.)

17 T: Yes and the direction. What is it about these that produces a lot of evaporation?

(Correction: T presents another factor; Rule: point out a necessary factor.
Diagnosis: ask for intermediate factors.)

18 S: I just had a thought about an answer or lack of one a bit back that I thought you'd be interested in. Seeing as how I don't really know that much about the geography of this area, however, I failed to make a good analogy based on common sense reasoning with respect to questions 9 and 11 which essentially asked the same question. I could have drawn a comparison to an everyday living experience about water, moisture and air for example, the boiling of a kettle, or other in order to derive an appropriate response; despite the differences of situation - the similarity does exist quite clearly. Now, to answer your most recent question - I don't have any information to indicate direction of the current; but if it's flow were southern would that make it warmer? I'm not sure that this makes much sense?

(S understands how warmth of water affects evaporation based on kettle analogy; remove from hold list.)

(S has an outside domain bug which says: Currents which flow south are warm.)

19 T: No the current comes from the south and that is why it's warm. Can you guess how it gets to Oregon, i.e. the route?

(Correction: inform student.
Diagnosis: ask for intermediate factors.)

20 S: The origin of the current, if south, where one normally tends to associate south with warm climate - equatorial current- would provide the reason for it being warm it being the water; as for how it gets to Oregon - I don't know.

(S acknowledges fix of bug, but doesn't know intermediate factors.)

21 T: The current is called the Japanese current and it comes from the Equator along the coast of Japan and across to Canada and Oregon. Is there another current you know about with the same pattern?

(Correction: inform student of the correct fact.
Case selection rule: Pick an example with the same factors; T attempts to introduce the Gulf Stream.)

22 S: I don't know what you mean - the equatorial current?

(S doesn't see generalization)

23 T: I meant the Gulf Stream. I wanted you to see the general pattern of currents in the world. OK. Why do you think the fact that the air over the current is warm affects the amount of evaporation?

(T presents the case and assumes S knows about Gulf Stream and can see the analogy which completes the first-order coverage of current flow.
Diagnosis: Pops back to how warm air affects evaporation, skipping how warm water does because of kettle analogy;
Rule: ask for intermediate factors.)

24 S: I don't know

25 T: warm air holds more moisture so the fact that the air current is warm permits more evaporation. How does the air over the ocean get over Oregon or alternatively why there rather than elsewhere?

(Correction: point out a necessary factor.
T completes warm air script for first-order theory;
Diagnosis: pops back to how moist air gets over Oregon;
Rule: ask for intermediate factors.)

26 S: I would assume it gets carried there by the wind i.e. or some such force.

(S identifies force but not direction; T assumes S can deduce direction from Japanese current)

27 T: Yes and the winds are blowing toward the land there. You mentioned the mountains in Oregon. How do you think they affect the rainfall there?

(T mentions wind direction, completing first-order script for getting over land;
Diagnosis: pops back to mountains; Rule: ask for prior factors.)

28 S: When the moisture laden air reaches the mountains it is forced to rise and consequently the air cools ? causing rainfall no?

(S understands role of mountains, but still fails to mention why cooling causes rainfall.)

29 T: Why does cooling cause rainfall?

(Diagnosis: ask for intermediate factors.)

30 S: It forces the air to release its moisture, I think. p.s. I have two questions: how am I supposed to know that the winds are blowing toward the land - and what causes this? and what is the scientific background which explains why warm air holds more moisture?

(S does not supply missing step. The first question reveals S did not understand wind direction. The second question asks for underlying script in a second-order theory.)

31 T: Cooling causes rainfall because cool air holds less moisture. Winds are blowing toward land because they come across from Japan rather than from some other direction. Warm air holding more moisture is tied up with the fact that the molecules are moving around more and hence are less densely packed together, that's all.

(Correction: T points out necessary factor, which is the same step as the one the S asked to have explained in 2nd question.
Correction: T gives relation between Japanese current and wind direction at Oregon in answer to first question. T gives physical process in answer to second question.)

The dialogue can be simply characterized as a consideration of a single paradigm case: Oregon. It begins with a long diagnostic section (line 1-8) in which the tutor corrects only one factual error, but isolates two factors the student knows about, the ocean and the mountains, and three major bugs: incorrect or missing scripts for 1) why the air is moist, 2) why it is blown over Oregon and 3) why cooling results in rain. The remainder of the dialogue follows from more detailed sequences of diagnoses and corrections aimed at correcting these problems. The tutor pursues the temporally prior subscript about moist air and tries to diagnose the problem more specifically (lines 9-12). The tutor corrects bugs about the source of the evaporation, mentions the factors of air and water temperature (lines 13-15), and then pursues the ocean-current subscript (lines 15-23). During the ocean-current interchange the student interrupts and informs the tutor that she understands how water temperature affects evaporation, allowing the tutor to remove that factor from his hold stack. The tutor then completes the air temperature subscript (lines 23-25) and returns to the problem of winds identified in the initial diagnosistic part of the dialogue. The wind subscript is completed (lines 25-27). The tutor returns to the mountains factor (originally mentioned in line 6) and diagnoses that the student does understand their role (lines 27-28). In the final segment, the tutor returns to the remaining bug, why cooling leads to rain, and completes the tutorial of the first-order causal script for the case of Oregon.

There are obviously several difficult problems to be solved before dialogues of this sort can be carried on between a computer and a student. No existing system can support the level of language comprehension necessary to understand all of the student's responses. Diagnosis of students' conceptual bugs is not well enough understood to build a system which performs adequately. Neither is any existing system goal driven in a way that allows it to carry on good Socratic dialogues. The goals and rules we have outlined provide an initial characterization of the goal structure of Socratic dialogues. We believe that the refinements of the rules, and more specification of the diagnostic and case-selection processes will result in a complete and concise theory of tutors' goal structure which can be implemented as part of the Why System.

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